Supplementary material

February 24, 2017

Here we discuss the sensitivity of the scalings of precipitation extremes to the sampling methodology. We also analyze the joint distribution of the mean vertical velocities at 500 hPa and modeled precipitation for +6 K to show that results reported in the main article are robust to the magnitude of SST changes.

1 Sensitivity to sampling

To test the sensitivity of our scaling results to statistical sampling, we derive the extremes' scaling using another sampling technique. Instead of considering the tropical data for the entire month of February, as in our original analysis, we consider the tropical data at 7-day intervals. That is, we consider four consecutive data sets over the month of February. Extreme precipitation values (based on percentiles) are computed for each of these data sets. The mean of the SST scalings of these four extremes then represents the scaling over the month of February. Identical scalings are obtained when the mean of the extremes over the four samples are calculated first and then these means are scaled with SST. Figure 1 (a), (b), and (c) show the scaling of the tropical extremes with Tiedtke, BMJ, and GFS respectively (compare to Figure 2 (d), (e), and (f) from the article). Figure 2 shows the scaling of the grid-scale and convective contributions to the tropical extremes (compare to Figure 4 from the article). Similar analysis is performed with two and seven samples (each sample lasting two weeks and four days, respectively) and the scaling remains approximately invariant. The robustness of the scalings to these differing sampling methods makes a strong case for the generality and robustness of the results discussed in the article.

2 Difference between +6 K and Ctr case

To explore if and to what extent the relationship between mean vertical velocities and precipitation extremes discussed in our article is sensitive to the magnitude of SST changes, here we analyze the difference in the joint histogram of W_{500}-precipitation between the +6 K case and the Ctr case (Figure 3, to be compared with Figure 5). We see that the relationship between the grid-scale precipitation and the resolved vertical velocity remains linear. Similar to the $+8K - $ Ctr case, the convective precipitation shows no such relationship with the resolved vertical velocity. Additionally, the response of the resolved vertical motion to SST warming remains robust, with Tiedtke generating stronger resolved motions in +6 K than in the Ctr, GFS weaker resolved motions, and BMJ featuring an almost neutral response.

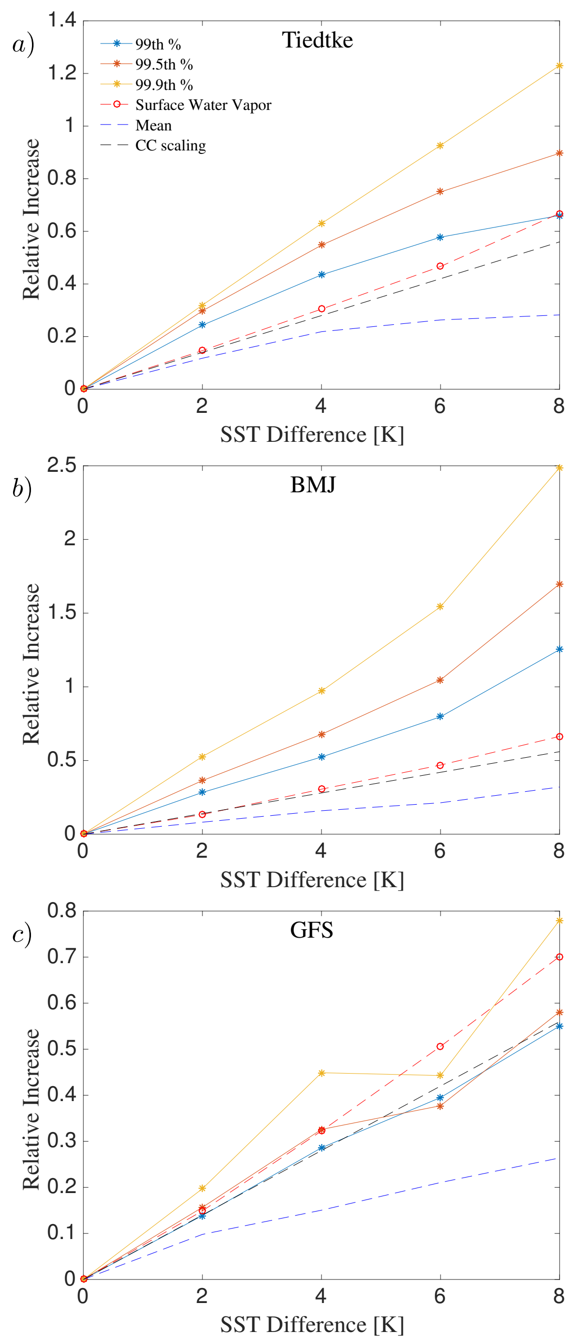

Figure 1: Alternative scaling of instantaneous tropical precipitation extremes (30°S to 30° N) with Tiedtke (a), BMJ (b), and GFS (c) convection parameterizations, respectively. Compare to Figure 2 (d), (e) and (f) from the article.

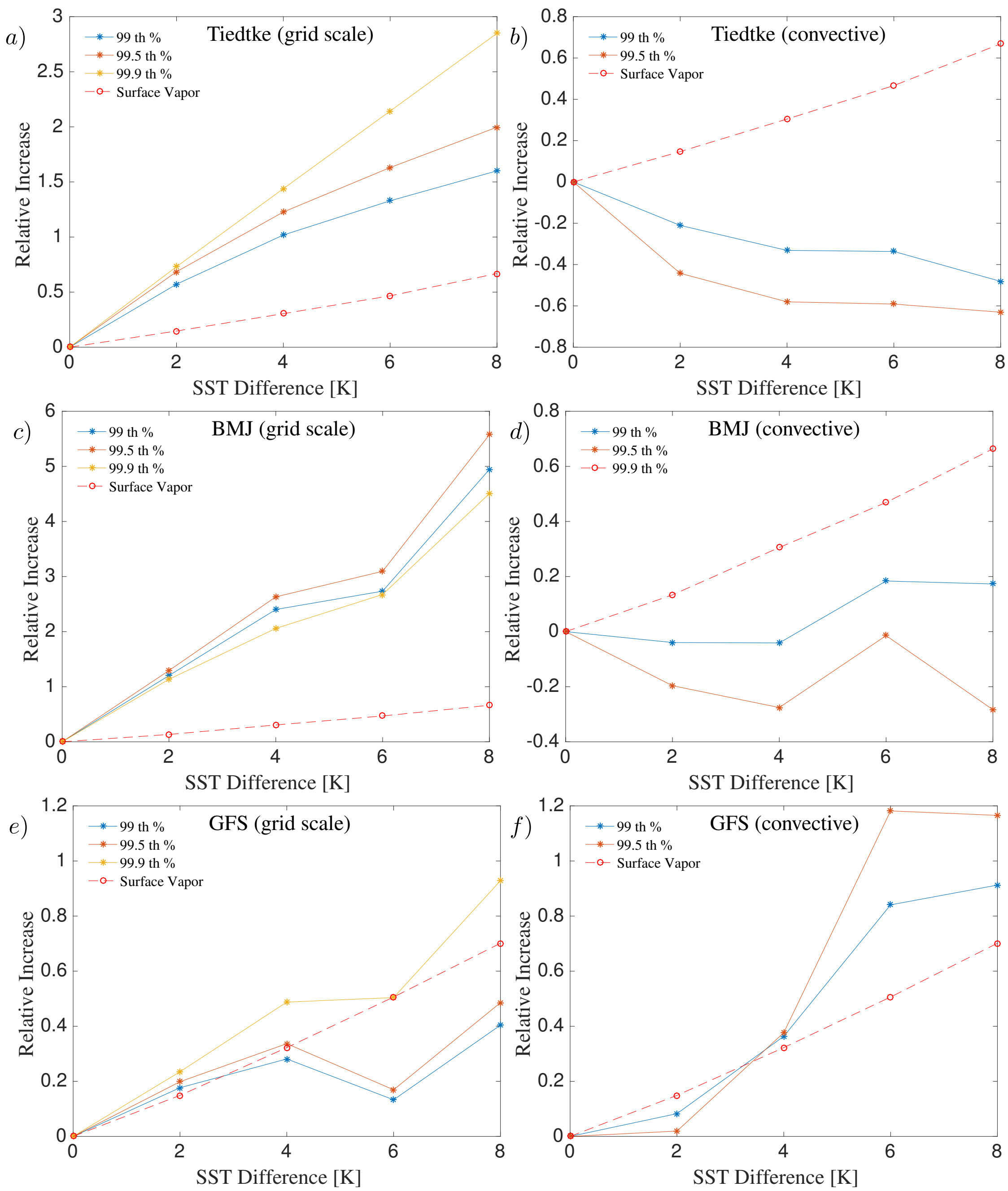

Figure 2: Alternative scaling of contributions to tropical extremes (30°S to 30° N) from the grid-scale (a, c, e) and convective (b, d, f) precipitation with the Tiedtke, BMJ, and GFS convection parameterizations, respectively. Compare to Figure 4 from the article. Scaling of the convective contribution to the 99.9% is not shown since such data points are too few to allow meaningful interpretation.

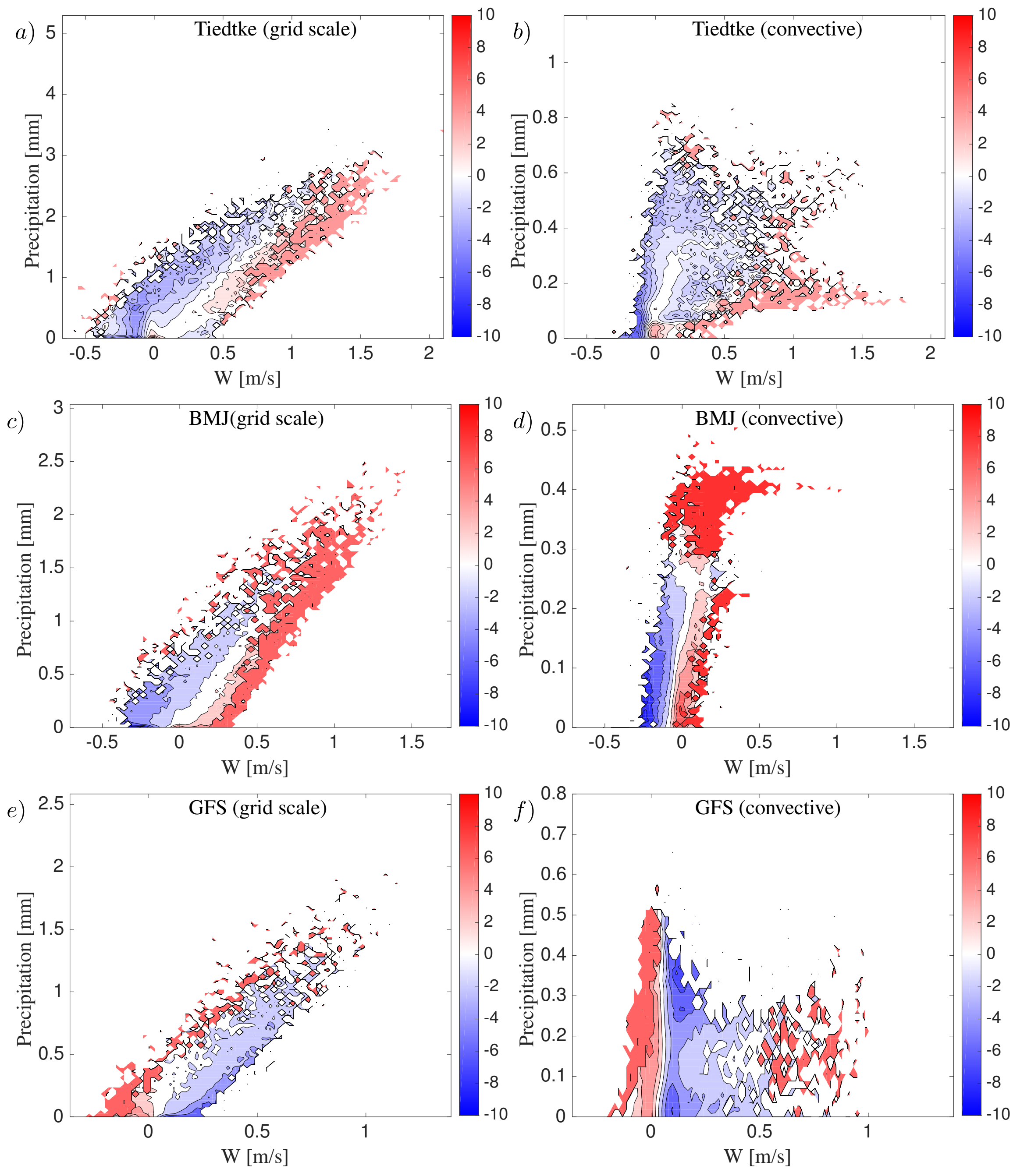

Figure 3: Anomalous (+6K−Ctr) logarithm of joint (resolved vertical velocity at 500hPa, W_{500}-precipitation) histograms for grid-scale (a, c, e) and convective (b, d, f) precipitation with the Tiedtke, BMJ, and GFS convection parameterizations, respectively.